

Theory of harm modelling

Introduction

1. This appendix discusses the methodology behind modelling the possible 'Theory of harm', and the profit incentives that could be available to FirstGroup. It refers to the bus–rail overlaps that exist between FirstGroup's bus routes and the GWF. The appendix also outlines a worked example of theory of harm modelling as well as summary tables showing the outputs of the modelling.

Theory of harm

2. The principle behind the theory of harm arises from the common ownership of all rail and bus routes on specific flows. An independent bus operator may be discouraged from increasing its prices for the fear of losing passengers to alternative forms of transport. However, if the bus operator also owned the competing rail network, then increasing bus fares could be profitable so long as a significant portion of passengers who switch do so to rail rather than to other transport alternatives. Accordingly, for this strategy to be profitable, a significant portion of bus passengers will have to view the overlapping rail service as a viable substitute.
3. In principle, bus frequencies could be reduced or bus fares increased, with the lost revenue from passengers switching away from bus being more than offset by the additional rail fares from those passengers who switch to rail, lower bus operating costs and, in the case of increased fares, the increase in revenue from passengers remaining with the bus. Theory of harm modelling attempts to estimate the possible profit outcomes arising from reducing bus frequencies and increasing bus fares. The model applies estimations on the demand responsiveness of passengers to changes in fares and frequencies (price and service elasticity¹), and the ratio of passengers that divert to rail (diversion ratio).

Factors affecting profit incentives

4. The potential to increase profits is greatest when overlapping flows make up a large portion of a bus route. A bus operating company is less likely to increase fares or reduce frequencies if overlapping passengers account for only a small portion of total route passengers. In this scenario, the loss of revenue from non-overlapping passengers shifting away from bus is likely to exceed the incremental revenue from overlapping passengers that shift to rail. The existence of profit incentives is unlikely when overlapping flows account for less than 10 per cent of a route (in terms of passenger numbers).
5. The incentive to shift passengers from bus to rail arises in part from rail fares often being higher than bus fares over comparable flows, most notably at peak times. On the basis of information supplied by FirstGroup, average revenues per passenger are higher for rail services relative to corresponding bus services for many overlapping flows.

¹The model uses the arc elasticity formula when calculating the price responsiveness of passengers, which equals [change in Q/average change in Q's]/[change in P/average change in P's].

6. The increase in profits from transferring passengers from bus to rail is also due to bus operations having a high proportion of costs that are variable or semi-variable. Rail operations, on the other hand, have largely fixed costs. The rail franchise agreement determines the mileage to be operated and imposes performance penalties for failing to run the required service. There are no such service level requirements for bus operations, and this, combined with the different characteristics of running a bus service, mean that variable costs such as drivers, fuel and tyres can be reduced by a discretionary lowering of service levels. Thus variable cost savings can be achieved from reducing bus services, but extra train passengers generally add little to train costs.
7. The existence of revenue risk may be an important factor in determining the incentive to shift bus passengers to rail. Revenue risk would most likely be shared between the TOC and the DfT through a cap-and-collar mechanism. This sharing arrangement could reduce profit incentives as some incremental rail revenue would be shared with the DfT. [X]

Theory of harm modelling

8. The modelling assumes that all rail costs are fixed and that a large portion of bus costs (drivers, fuel etc) are variable to the mileage of each service. [X]
9. The modelling requires estimates on how passengers will react to fare increases and service reductions. Elasticity² estimates depend on various factors such as fare levels, the size and direction of fare changes, income levels, car availability etc. It is not possible to obtain elasticities for each route, which would take into account route-specific factors such as route distance, social-demographic profiles and the existence of other modes of transport. Work carried out by previous transport studies³ on transport elasticities in the UK suggests that short-run price elasticity on urban bus services range from -0.3 to -0.5 , and that service elasticity ranges from -0.25 to -0.40 . However, applying short-run elasticities would produce results that suggest profitability could be improved regardless of the merger. To consider the implications of longer-term elasticities, the modelling also uses a price and service elasticity of -1.0 or greater.⁴
10. The modelling also requires estimates of diversion ratios, ie the ratio of passengers who divert from bus who end up shifting to rail. It is possible that only a small proportion of the passengers will divert to rail, which would affect profit outcomes significantly. The survey results suggested that 20 to 40 per cent of bus passengers on key overlapping flows would switch to rail in the case of fare increases and service reductions. We have applied a diversion ratio of 25 per cent in the modelling below.
11. The difference between the average revenue per passenger for rail and bus has been applied, as some of the incremental revenue from shifting passengers arises from rail fares often being more expensive than bus fares. These averages have been obtained from data on overlapping flows, and the difference between rail and bus may reflect the differences in composition of ticket types used. The model also has the option to apply actual ticket values rather than average revenues per passenger.
12. GWF's post-merger rail market share on each particular rail flow has been taken into account. The modelling assumes that the amount of incremental rail revenue received

²The reduction in bus passengers in response to increased fares or reduced frequency.

³FirstGroup/Scotrail inquiry (2004).

⁴See Appendix D for the derivation of elasticity estimates used in the modelling.

is limited to the post-merger rail market share GWF will have on each flow. The modelling below also assumes that GWF will derive only 75 per cent of its share of rail revenues to reflect the revenue sharing arrangements it will have with the DfT.

Cardiff Central to Swansea example

13. Figure 1 shows the simulated profit outcome from increasing bus fares on the Cardiff Central to Swansea flow, operated by FirstGroup on its 100 bus route, which has a journey time of 60 minutes. Frequencies are every 60 minutes throughout the day. GWR operates a 55-minute service at intervals of every 60 minutes off-peak. The average revenue per passenger is £[x] for bus and £[x] for rail. [x]

FIGURE 1

Cardiff Central to Swansea—bus fare increase

[x]

Source: CC study.

14. If the demand response to a fare increase is an elasticity of -0.4 across the route, including overlapping and non-overlapping passengers, and if the diversion ratio was 25 per cent, then the expected loss of bus patronage from a 10 per cent fare increase would be 4 per cent across the route, which would equate to gain of bus revenue of £[x] ($£[x] - £[x] - £[x] - £[x]$). The incremental revenue arising from passengers switching to rail would amount to £[x], leaving a net increase in passenger revenue of £[x].
15. Figure 2 shows the projected profit outcome from reducing bus services on the same route by 10 per cent, equivalent to about two services a day. Using the same diversion ratio as above and a service elasticity of -0.4 , there would be an increase in profits of £[x]. It should be noted that the increase in profit arises from the cost savings from the reduction in bus services. These savings are obtainable regardless of the merger.

FIGURE 2

Cardiff Central to Swansea—bus service reduction

[x]

Source: CC study.

Summary tables

16. Table 1 shows the profit outcomes from increasing bus fares and reducing services on the FirstGroup routes containing the overlapping flows (49 routes), by 10 per cent, including the 100 route above. The table suggests that, assuming an elasticity of -0.4 and diversion ratios of 25 per cent, a majority of routes would realize increased profits from bus fare increases and about half for service reductions.

TABLE 1 Effect of fare increase and service reduction—elasticity of -0.4, diversion ratio -25 per cent

	Fare increases			Service reductions				
	Extra rail revenue	Extra bus revenue	Total extra profits	Uplift from rail as % of bus route revenue	Extra rail revenue	Cost savings less lost bus revenue	Total extra profits	Uplift from rail as % of bus route revenue
701,702								
8,8A,9,9A								
100								
X3								
X4								
X5,X6								
14								
16								
17,17A,17B								
18,18A,18B								
21,21A,21B								
27,27B								
68,88,88B								
89,90								
X80,X81								
10,10A,10B,10C,10D								
X55,X56								
5								
17								
18								
41								
X57								
60,60A								
5								
10								
16,17								
178								
234								
237								
267								
337								
339								
342								
349								
350,351,352								
353								
354								
362								
364								
X1								
3,3A,3C								
X4,X5								
X23								
X29								
X39								
X40								
X42								
21,21A,921								
44								
Total routes								

Source: CC study.

17. For all routes in the case of a fare increase, the uplift in revenues arising from merger (rail revenue) is relatively small. At an elasticity of -0.4, FirstGroup could profitably raise bus fares prior to the merger and realize a revenue uplift of about £[£] a year. The acquired rail franchise would add only £[£] to the revenue uplift. When compared against the total bus revenue for each route, the revenue uplift from rail would equate only to about [%] per cent of total bus route revenue for all of the routes in Table 1.

18. For the case of a 10 per cent service reduction, the rail uplift would be the same. For those routes where the service reduction is profitable, this rail uplift accounts for, on average, about [X] per cent of bus route revenue.
19. Using elasticity of less than -1.0 , the total uplift would be smaller, and for most routes, negative. However, the rail portion of any uplift would be greater. Table 2 shows the profit outcomes from increasing bus fares and reducing services on all overlapping routes, assuming a price elasticity of -1.2 .⁵ The table shows that the revenue uplift from rail increases to about £[X]. For those routes where the fare increase or service reduction is profitable, the rail uplift equates to about [X] per cent of bus route revenue.

⁵A diversion ratio of 25 per cent may be an overestimate if long-term elasticities are used, as a greater percentage of passengers may switch to private transport (car) over the longer term.

TABLE 2 Effect of fare increase and service reduction— elasticity of -1.2, diversion ratio -25 per cent

	Fare increases			Uplift from rail as % of bus route revenue	Service reductions		
	Extra rail revenue	Extra bus revenue	Total extra profits		Extra rail revenue	Cost savings less lost bus revenue	Total extra profits
701,702							
8,8A,9,9A							
100							
X3							
X4							
X5,X6							
14							
16							
17,17A,17B							
18,18A,18B							
21,21A,21B							
27,27B							
68,88,88B							
89,90							
X80,X81							
10,10A,10B,10C,10D							
X55,X56							
5							
17							
18							
41							
X57							
60,60A							
5							
10							
16,17							
178							
234							
237							
267							
337							
339							
342							
349							
350,351,352							
353							
354							
362							
364							
X1							
3,3A,3C							
X4,X5							
X23							
X29							
X39							
X40							
X42							
21,21A,921							
44							
Total routes							

Source: CC study.

20. Table 3 compiles the data from Table 1 into the various bus operating companies in the GWF area.

TABLE 3 Effect of fare increase and service reduction: all routes grouped by bus operating region

	Fare increases				Service reductions			
	Extra rail revenue	Extra bus revenue	Total extra profits	Uplift from rail as % of bus route revenue	Extra rail revenue	Cost savings less lost bus revenue	Total extra profits	Uplift from rail as % of bus route revenue
Berkshire								
Bristol								
Cymru								
Devon & Cornwall								
Hampshire & Dorset								
Somerset & Avon								
Wyvern								
Total								

Source: CC study.

*Elasticity -0.4, diversion ratio 25 per cent.

- The bus operating companies shown above derive combined bus revenues of over £180 million a year. The revenue uplift shown in Table 1 equates to about [%] per cent of existing bus revenue for the above routes, and only [%] per cent of the consolidated bus revenue of the bus operating companies in the GWF area.
- The filtering analysis carried out by the CC on the overlapping flows had eliminated several routes where overlapping flows faced countervailing competition from third-party bus (or coach) operators. A £10,000-a-year threshold was also applied to each overlapping flow. Of the total 49 routes analysed in Table 1 and Table 2, 14 routes (119 flows) had been filtered out, leaving 35 routes (65 flows) for a more in-depth competitive assessment. Table 4 shows the revenue uplift outcomes for the remaining 35 routes, compiled into the seven bus operating companies in the GWF area.

TABLE 4 Effect of fare increases and service reduction: 35 filtered routes grouped by bus operating region

	Fare increases				Service reductions			
	Extra rail revenue	Extra bus revenue	Total extra profits	Uplift from rail as % of bus route revenue	Extra rail revenue	Cost savings less lost bus revenue	Total extra profits	Uplift from rail as % of bus route revenue
Berkshire								
Bristol								
Cymru								
Devon & Cornwall								
Hampshire & Dorset								
Somerset & Avon								
Wyvern								
Total								

Source: CC study.

*Elasticity -0.4, diversion ratio 25 per cent.

- The more detailed competitive analysis on the remaining 35 routes involved an assessment of the extent of competition between the above bus services and the anticipated train services to be offered by the GWF, including the comparative frequency of services. This analysis eliminated a further 26 routes (48 flows), with nine routes (17 flows) remaining. Table 5 shows the revenue uplift outcomes for these nine routes.

TABLE 5 Effect of fare increases: nine filtered routes

	Fare increases				Service reductions			
	Extra rail revenue	Extra bus revenue	Total extra profits	Uplift from rail as % of bus route revenue	Extra rail revenue	Cost savings less lost bus revenue	Total extra profits	Uplift from rail as % of bus route revenue
100								
X3								
27,27B								
X80,X81								
339								
350,351,352								
353								
X1								
X39								
Total								

Source: CC study.

*Elasticity -0.4, diversion ratio 25 per cent.

24. FirstGroup argued that there was little scope for service reduction of 10 per cent, if 'clock-face timetables' were to be retained—ie buses scheduled to depart at the same minutes past the hour. For the most frequent route, the X39, the minimum increase in headways would be 25 per cent, from 12 to 15 minutes an hour; for a 15-minute route 33 per cent (to 20 minutes); for a 20-minute route 50 per cent (to 30 minutes) and for a 30-minute route 100 per cent (to 60 minutes). The above figures are, however, only illustrative. Larger proportionate decreases in service clearly would have a larger impact on additional revenues, although not proportionately so, in that, as FirstGroup argued, elasticities may be higher, the lesser the frequency of service and the greater the additional waiting time incurred. At higher elasticities, significant reduction in service would be unprofitable if applied across all routes: the extra rail revenue generated would be less than the losses to the bus business. Although substantial service reduction may be profitable on some routes, there is considerable uncertainty as to the scale of the incentives to reduce services more significantly, and the number and identity of routes on which it would be profitable to do so, depending on the assumptions used.

Summary

25. The above theory of harm modelling shows that the potential rail revenue uplift available to FirstGroup is relatively minor compared with the existing bus revenues on routes overlapping with the GWF. When using a fare and service elasticity of -0.4, most of the total uplift in revenue is derived from extra revenue from remaining bus passengers and only a very small proportion is derived from passengers that switch to the overlapping rail service. This suggests that nearly all of the potential harm would exist regardless of the merger. If fare and service elasticity were less than -0.4, there would be a higher rail uplift. However in many cases the total uplift would be negative, particularly for an elasticity of less than -1.0. Even for positive revenue uplifts, the rail portion would account for less than 1 per cent of existing bus route revenues. This would suggest that in this case the rail overlaps would add little to incentives to increase fares and reduce services.